

## COEXISTENCE OF LTE OPERATED IN UNLICENSED BAND

### TECHNICAL FIELD

**[0001]** This invention relates generally to wireless communication, and more specifically relates to wireless radio operation on unlicensed spectrum in coordination with a network operator running licensed spectrum.

### BACKGROUND

**[0002]** This section is intended to provide a background or context to the invention that is recited in the claims. The description herein may include concepts that could be pursued, but are not necessarily ones that have been previously conceived, implemented or described. Therefore, unless otherwise indicated herein, what is described in this section is not prior art to the description and claims in this application and is not admitted to be prior art by inclusion in this section.

**[0003]** Release 10 of the evolved universal terrestrial radio access network (E-UTRAN, also known as long term evolution or LTE) operates with carrier aggregation, in which the whole system bandwidth is divided into multiple component carriers (CCs). FIG. 1A is an early rendition of the LTE carrier aggregation concept, in which the 100 MHz bandwidth is divided into five 20 MHz CCs each of which was backwards compatible with legacy Release 8. Each CC is sometimes referred to as a primary CC or a secondary CC, since Release 10 compatible user equipments (UEs) will be allocated one primary CC and possibly also one or more secondary CCs.

**[0004]** LTE-Advanced (LTE-A) is directed toward providing higher data rates at very low cost. One significant change is that LTE-A is to include bandwidth extensions beyond 20 MHz, for example aggregations of larger or smaller CCs than 20 MHz.

**[0005]** But these bandwidth extensions alone are not anticipated to meet future wireless needs; the amount of wireless traffic is forecast to increase by a factor of 1000 between 2010 and 2020. To cope with this burgeoning need, cellular operators are looking toward exploiting unlicensed radio spectrum for offloading traffic from their crowded licensed spectrum whenever practical. Unlicensed bands include what is known as the industrial, scientific and medical (ISM) band as well as television whitespaces (TV WS) which were once set aside for broadcast television in the United States. See for example the relevant references cited below.

**[0006]** There are two main scenarios for deploying LTE in the unlicensed band. In one case the unlicensed LTE is running alone, not unlike conventional WiFi wireless access networks (WLANs). The other case has the LTE cellular operator running two LTE network at the same time, one in the licensed band for wide coverage and one in the unlicensed band for data offloading. The latter scenario is relevant to these teachings.

**[0007]** In a carrier aggregation system such as LTE the unlicensed band can be designated as a secondary CC. Offloading data traffic to a secondary CC in the unlicensed band can potentially provide a very efficient way for having LTE operate in both licensed and unlicensed bands simultaneously. But this raises the issue of coexistence given the nature of the unlicensed band. These teachings are directed toward handling the coexistence issues when a cellular radio access technology such as LTE is operated over both licensed and unlicensed bands at the same time.

**[0008]** Relevant teachings in this regard may be seen at the following papers:

**[0009]** LICENSE-EXEMPT LTE SYSTEMS FOR SECONDARY SPECTRUM USAGE: SCENARIOS AND FIRST ASSESSMENT by Rahman, M. I.; Behravan, A.; Koorapaty, H.; Sachs, J.; and Balachandran, K. [2011 *IEEE International Symposium on Dynamic Spectrum Access Networks*, pp 349-358].

**[0010]** A FRAMEWORK FOR FEMTOCELLS TO ACCESS BOTH LICENSED AND UNLICENSED BANDS by Feilu Liu, Erdem Balay, Elza Erkip and Rui Yangy [Interdigital Communications; undated].

**[0011]** A DYNAMIC SPECTRUM ACCESS SCHEME FOR UNLICENSED SYSTEMS COEXISTING WITH PRIMARY OFDMA SYSTEMS by Pham, H. N.; Gronlund, P. I.; Engelstad, P. E.; and Grondalen, O. [2010 *7<sup>th</sup> IEEE Consumer Communications and Networking Conference*, pp 1-5].

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]** FIG. 1A is a schematic diagram of an early version of carrier aggregation for the LTE radio access technology, in which five component carrier bandwidths are aggregated into a single system bandwidth.

**[0013]** FIG. 1B is a schematic diagram of a radio environment in which embodiments of these teachings may be practiced to advantage.

**[0014]** FIG. 2 is an exemplary signaling diagram between a LTE AP operating in an unlicensed secondary component carrier and a LTE eNB operating in a licensed component carrier according to a non-limiting embodiment of these teachings.

**[0015]** FIG. 3 is a logic flow diagram that illustrates from the perspective of a network access node the operation of a method, and a result of execution by an apparatus of a set of computer program instructions embodied on a computer readable memory, in accordance with the exemplary embodiments of this invention.

**[0016]** FIG. 4 is a simplified block diagram of a user equipment and an E-UTRAN eNB access node and an access point operating in cooperation with the cellular access node, all of which are exemplary devices suitable for use in practicing the exemplary embodiments of the invention.

### SUMMARY

**[0017]** In a first exemplary aspect of the invention there is a method which includes: collecting at a cellular network node information about at least interference in a plurality of channels in unlicensed spectrum; and using the collected information to update an allocation of the channels among at least two different access points.

**[0018]** In a second exemplary aspect of the invention there is an apparatus which includes at least one processor and at least one memory including computer program code. The at least one memory and the computer program code are configured, with the at least one processor and in response to execution of the computer program code, to cause the apparatus to perform: collecting information about at least interference in a plurality of channels in unlicensed spectrum; and using the collected information to update an allocation of the channels among at least two different access points.

**[0019]** In a third exemplary aspect of the invention there is a computer readable memory storing a program of instructions comprising: code for collecting information about at least interference in a plurality of channels in unlicensed